Factors of electric vehicle adoption: A comparison of conventional and electric car users based on an extended theory of planned behavior

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Abstract

Increasing the share of battery electric vehicles (BEV) in the total car fleet is regarded as a promising way to reduce local car emissions. Based on online surveys in Denmark and Sweden, this study compares BEV users' (*n*=673) and conventional vehicle (CV) users' (*n*=1794) socio-demographic profiles, attitudinal profiles and mobility patterns. In line with previous research, BEV users are typically male, highly educated, have high incomes and often more than one car in their household. Additionally, BEV users perceive less functional barriers towards BEV use and have more positive attitudes and norms than CV users. The different profiles of these user groups suggest a separate analysis of potential factors of BEV adoption in both groups. In regression analyses, CV and BEV users' intention to use/purchase a BEV is modelled based on factors of the Theory of Planned Behaviour extended by personal norm, perceived mobility necessities and BEV experience. For CV users, symbolic attitudes related to BEVs are the most important factor of intention, while perceived functional barriers in terms of driving range are most relevant for BEV users' intention. How BEV users cope with trips of longer distance seems of particular relevance. In multiple car households, we found the percentage of actual BEV usage related to the type of other cars in the household, perceived functional barriers of BEVs as well as (successful) behavioural adaption to longer trips by BEVs. Based on the results, we discuss ways to increase BEV adoption for current users and non-users.

Keywords

Electric vehicles; intention; attitude; subjective norm; personal norm

1. Introduction

The quality of life in cities suffers from noise, particles, and other pollutants produced by private cars and other motorised transport modes. Several studies have found a significant relation between traffic related emissions and health problems (Ellermann, 2014; Krzyzanowski, Kuna-Dibbert, & Schneider, 2005). In addition, private transport is a major driver of carbon emissions, which contribute to climate change (Chapman, 2007). Despite these negative effects, car use is often associated with positive motives like time-savings, convenience, freedom and status (e.g., Anable & Gatersleben, 2005; Beirão & Cabral, 2007; Steg, 2005). Thus, many authorities consider increasing the share of battery electric vehicles (BEVs) in the total car fleet as a more realistic way to fulfil their environmental goals than individual car use reduction. Contrary to internal combustion engine vehicles, BEVs are almost silent at low speeds, have almost no local air emissions and with a higher share of renewable energy sources in the electricity production, BEVs can contribute to reducing global emissions from transport (Odeh, Hill, & Forster, 2013).

In the last decade, the car industry has invested huge amounts in BEV technology, leading to a much larger selection of car models with better comfort, driving range and options for recharging the batteries. While the market previously mostly supplied BEVs in the smaller car segments, it now also covers the premium and luxury segment. This might have led to a more positive image of BEVs and provides better possibilities to increase the market share.

Still, the uptake of BEVs is not increasing as quickly as one could imagine given the recent improvements of vehicle technology and infrastructure. In Denmark, for example,

there is a reasonably good coverage of public charging locations well distributed across the country (540 charging locations of which 235 are quick charging; ladekortet.dk, 19/9/2017). Still the BEV share of new car purchases was only 0.5% in 2016 (Autobranchen, 2017; Danish Electric Vehicle Alliance, 2017). While charging infrastructure and available and affordable car models are relevant preconditions for BEV adoption, they are not sufficient ones. To identify ways to increase BEV uptake, we need a better understanding of the factors that influence BEV adoption of conventional car users but also ensure that current BEV users will choose a BEV again.

As previous research has shown (e.g., Bjerkan et al., 2016; Langbroek et al., 2017), BEV users differ from non-users in their demographic profiles (e.g. more males, higher incomes) and can thus be regarded as a distinct target group (see Section 2.1). Thus, we consider it relevant to examine factors of BEV adoption separately for current BEV users and non-users.

We expect that for the more affluent BEV owners, financial barriers play a minor role, while they could be a main barrier for non-users. By contrast, BEV users' intention to use and buy a BEV again, will be influenced by their actual experience with the BEV (see Section 2.2), while the public image of BEVs and related social norms may play a bigger role for non-users' intention. Such differences in the factors of BEV adoption would imply that both groups should be addressed by different strategies when aiming to increase BEV uptake, and that findings from one group cannot be generalised to other vehicle user groups.

This paper examines these assumptions based on online surveys conducted in Denmark and Sweden among BEV users and conventional vehicle (CV) users. The surveys assessed

people's mobility behaviour, the intention to use and purchase an EV (again) and potential influencing factors. To ensure the inclusion of the most relevant psychological factors, we relied on the Theory of Planned Behaviour (Ajzen, 1991) – probably the most frequently and successfully applied behavioural theory for predicting pro-environmentally transport choices. An advantage of this theory is its openness for the inclusion of additional factors, such as environmental norms and symbolic-affective motives, which we consider relevant in the context of BEV adoption as this paper elaborates in Section 2.3.

2. Past research

2.1 Socio-demographic profile of BEV owners

Studies that compared BEV owners either with the general population or other car owner groups result in a quite clear socio-demographic profile of BEV owners. Accordingly, BEV users are more likely to be male, of higher education and income, and are more likely to have more than one car in their household (e.g., Bjerkan, Nørbech, & Nordtømme, 2016; 2016; Hjorthol, 2013). With regard to household size, there are some contradictory results. According to some studies BEV owners are more likely to live in larger households, more likely with children (Nayum, Klöckner, & Mehmetoglu, 2016; Peters & Dütschke, 2014), while a recent Swedish study found that they are more likely to live in smaller households than non-BEV owners (Langbroek, Franklin, & Susilo, 2017). The identified socio-demographic differences in BEV users and non-users suggest that we deal with different target groups that may be influenced by different needs and motivations.

2.2 The influence of BEV experience on attitudes, preferences and behaviours

The different characteristics of BEVs compared to CVs require some level of behavioural adaption of potential users as they might have to conduct some trips in another way or not conduct them at all due to the limited driving range. A number of studies conclude that a large share of households would be able to maintain their current mobility patterns with only a minor level of adaption with the currently available driving range of BEVs (Greaves, Backman, & Ellison, 2014; Pearre, Kempton, Guensler, & Elango, 2011). However, even if this evaluation is correct, it may be perceived differently by potential users.

As the BEV technology is an emerging technology with a rather low market share in most countries, few households have gained experiences with BEVs so far. Such experience is relevant to establish realistic attitudes and preferences for a new product as the BEV. Based on commercials, reviews and word-of-mouth information only, it is very difficult to evaluate whether a BEV would match the household members' lifestyle and cover their current mobility needs. To investigate whether attitudes and preferences towards BEVs change with experience, some studies have used vehicle trials and measured preferences and attitudes before and after the trial. Jensen et al. (2014) found that (particularly women's) attitudes towards the driving performance of BEVs became more positive with BEV experience, while concern about getting used to charging the car decreased. By contrast, concern about the ability to cover present mobility needs with a BEV increased. When modelling preferences for specific BEV specifications in a purchase situation, the driving range became significantly more important with experience (Jensen et al., 2013). Yet, Franke and Krems (2013) found that the minimal acceptable driving range of a BEV decreased significantly

with experience. In both studies, a decreasing desire for BEV purchase was found for experienced users compared to inexperienced users (Jensen et al., 2014; Franke, Bühler, Cocron, Neumann, & Krems, 2012), which is in line with previous findings (Gärling & Johansson, 2000). Also a more recent study (providing access to a 2012 BEV with claimed range of > 100 miles) showed that the performance ratings of BEVs increase after experience, while purchase considerations decrease, suggesting that "the disutility of short range outweighs the perceived benefit of better performance and driving experience." (Skippon, Kinnear, Lloyd, & Stannard, 2016, p. 39). In a study by Schmalfuß, Mühl, and Krems (2017) participation in a 24 hour BEV field test also led to a more positive evaluation of affective BEV attributes (e.g., acceleration, driving fun), while the evaluation of functional aspects (i.e. driving range, charging) and purchase intention remained unchanged

Studies have also investigated how access to a BEV changes driving behaviour and mobility patterns. In line with previous studies (e.g., Rolim, Gonçalves, Farias, & Rodrigues, 2012), Labeye, Hugot, Brusque, and Regan (2016) found that people adapt their driving style and daily routines to the use of BEVs. While operational skills (e.g. braking) are quickly adapted, the management of the limited range takes more time as it may include the reorganisation of activities and establishment of new habits including the reconsideration of mode choice for specific trip (Labeye et al., 2016).

Recent studies show that BEVs are used for more but particularly shorter trips, which could (partly) be conducted by foot or bike instead (Jensen & Mabit, 2017; Labeye et al., 2016; Langbroek, et al., 2017). This is probably done as driving a BEV is perceived less environmentally harmful compared to driving a CV (Labeye et al., 2016). This potential

rebound effect is supported by a study of Fujii (2010), which showed that people who replace their CV by a car that they perceive as an “eco-car” increase their mileage. Furthermore, Jensen and Mabit (2017) found that BEVs are more often used for well-planned trips (i.e. trips during weekdays in peak hours) and less often during weekends where more flexibility is required.

2.3 Applying the Theory of Planned Behaviour to BEV adoption

The psychological factors included in this study are chosen on the basis of the Theory of Planned Behaviour (TPB; Ajzen, 1991). The TPB has been applied and extended successfully for explaining a variety of transport-related decisions including mode choice (e.g., Bamberg, Ajzen, & Schmidt, 2003; Haustein & Hunecke, 2007; Heath & Gifford, 2002) and departure time choice (Thorhauge, Haustein, & Cherchi, 2016). For electric vehicle adoption, several studies have demonstrated the relevance of single TPB predictors or the TPB as a whole (Moons & De Pelsmacker, 2012; Schmalfuß et al., 2017; Wang, Fan, Zhao, Yang, & Fu, 2016).

TPB regards intention as the central determinant of behaviour. The intention to perform a behaviour is determined by three factors*: attitude, subjective norm,* and *perceived behavioural control*. Attitude is the degree to which the performance of a behaviour is positively or negatively valued; subjective norm is the perceived social pressure to engage in a behaviour; and perceived behavioural control refers to the perceived ability to perform a behaviour. TPB assumes perceived behavioural control to be a direct predictor of both intention and behaviour.

Studies on BEV adoption found all three TPB determinants of intention relevant. With regard to *attitude*, we can distinguish between functional, affective and symbolic attitudes. Research has shown that the high perceived purchase price has a negative effect on BEV adoption, which is only partly compensated by the lower operational costs (e.g., Egbue & Long, 2012; Graham-Rowe et al., 2012; Rezvani, Jansson, & Bodin, 2015; Skippon & Garwood, 2011). Another important functional barrier for BEV adoption is the limitation in driving range and related to that the time needed for charging and perceived inconvenience (e.g., Franke & Krems, 2013; Jensen, Cherchi, & Mabit, 2013; Schmalfuß et al., 2017; Skippon & Garwood, 2011). While BEVs are thus mostly associated with negative *functional* attitudes, they are by contrast associated with positive *affective* attitudes: People who tried a BEV mostly appreciate the driving experience connected to higher acceleration, smoothness and low noise (e.g., Jensen, Cherchi, & Ortúzar, 2014; Pierre, Jemelin, & Louvet, 2011; Schmalfuß et al., 2017; Skippon & Garwood, 2011; Skippon et al., 2016), although some people perceive the lack of engine noise also as challenging in relation to unprotected road users (Graham-Rowe et al., 2012; Labeye et al., 2016). In addition to these affective attitudes, people often attribute positive *symbolic* meanings with BEVs and their owners, such as higher status (Skippon et al., 2016), openness for new ideas and technologies, or environmental and social values (e.g., Graham-Rowe et al., 2012; Skippon & Garwood, 2011).

The relevance of symbolic and affective aspects of BEVs, such as perceived status and driving pleasure, as comparted to perceived functional or instrumental aspects, such as price and driving range, has been demonstrated in a study by Schuitema et al. (2013) who

found that “Instrumental attributes are largely found to be important because of their influence on perceptions of hedonic or symbolic attributes of BEVs or both” (p. 47), while their direct influence on BEV adoption was not found to be very strong. In line with that, a study by Moons and De Pelsmacker (2015) showed that external constraints and facilitators are less relevant for BEV usage intention as compared to emotional aspects.

Attitudes that relate to functional aspects of BEVs such as driving range (e.g., “BEVs have a too low driving range.”) are difficult to differentiate from the TPB construct of perceived behavioural control (e.g., “It is difficult to reach my destinations with a BEV.”). Due to their conceptual similarity, we refer to functional attitudes and perceived behavioural control as perceived functional barriers in this paper.

In addition to perceived barriers related to vehicle characteristics and infrastructure, Haustein and Hunecke (2007) introduced the concept of perceived mobility necessities. It has been added to TPB as a direct determinant of intention and behaviour to account for aspects of the personal living situation (e.g. a stressful/demanding lifestyle) that hamper the use of environmentally-friendly transport modes (Haustein & Hunecke, 2007). It may also be relevant in the context of BEV adoption as studies indicate that people consider their personal lifestyle as a barrier to BEV adoption: Peters and Dütschke (2014), for instance, identified “perceived compatibility of a BEV with personal needs” as the most influential factor of BEV purchase intention.

Finally, the impact of *subjective norm* on BEV adoption has been examined. In a study by Nayum et al. (2016) subjective norm, operationalized as expectations of relevant others to choose/buy a fuel efficient and environmentally friendly car, could not discriminate between

BEV owners and owners of other car types. While Schmalfuß et al. (2017) found a significant effect of subjective norm on BEV purchase intention, Peters and Dütschke (2014) showed that subjective norm only had a significant effect on people with lower or no interest in BEV purchase, while it had no effect on BEV users' and potential users' intention. The operationalization of subjective norm in this study was a bit broader, covering also symbolic aspects such as BEV status in society. Moons and de Pelsmacker (2015) found only a minor effect of subjective norm by peers but a greater effect through media on BEV *usage* intention, which they explain by the low distribution of BEV among peers at the stage of data collection (data of the study were collected in Belgium in 2012).

An additional factor that should be considered in terms of BEV adoption is personal norm (PN), which is the central variable in the Norm-Activation Model (Schwartz, 1977; Schwartz & Howard, 1981). In in the Norm-Activation Model, PN is defined as the intrinsic feeling of moral obligation to behave in accordance with the person's individual value system (Schwartz, 1977). Several studies have demonstrated a positive effect of PN on the use of environmentally friendly travel modes in addition to TPB constructs (e.g., Harland, Staats, & Wilke, 1999; Hunecke, Blöbaum, Matthies, & Höger, 2001; Nordlund & Garvill, 2003). There is also empirical evidence for the relevance of PN for the purchase intention of fuel-efficient cars (Peters, de Haan, & Scholz, 2015) and BEV adoption (e.g., Egbue & Long, 2012; Skippon & Garwood, 2012) though other studies indicate a low importance of environmental norms (e.g., Lane & Potter, 2007) or a different relevance for different consumer groups (Graham-Rowe et al., 2012).

Similar to subjective norm, Nayum et al. (2016) found that PN was not able to discriminate between BEV owners and owners of other car types. They interpret the low PN they found across owners of different car types (despite high overall levels of environmental concern and self-transcendence) by crowding out of intrinsic motivation by financial incentives provided by the Norwegian government for BEV purchase. This may be different in the context of our study as financial incentives to buy a BEV are lower in Denmark and Sweden as compared to Norway. Both Norway and Denmark have a quite high registration tax on cars and while BEVs in Norway are both exempt from VAT and registration tax, BEVs in Denmark are imposed with full VAT and 40% of regular registration tax. In Sweden, cars are in general cheaper and BEVs are subsidised with a fixed amount and a five year exempt from the annual circulation tax.

Taking country-specific differences into account, this study examines the relation of BEV users' and CV users' intention to use and buy a BEV (again) to the factors of TPB. We look at both user groups separately as we consider them as distinct target groups as will be confirmed by descriptions of their demographic profiles, mobility patterns, and BEV related attitudes and norms. While BEV adoption has been examined in the context of the TPB before, we extend TPB by personal norm and perceived mobility necessities and operationalise attitudes more specifically in relation to affective and symbolic motives. Because BEV experience has been shown to influence BEV usage and purchase intention (see Section 2.2), we also include retrospective measures of BEV experience and behavioural adaption in our analysis. We expect that the results will allow for specific conclusions on how to increase BEV adoption in both target groups.

3 Method

3.1 Sample and procedure

This study focusses on two target groups: (1) licensed drivers with at least one internal-combustion engine car (and no other car types) in their household (in the following referred to as “CV users”); and (2) drivers with at least one battery electric car in their household (in the following referred to as “BEV users”). Data were collected as part of the EU project GREAT (see www.great-region.org). Project partners E.ON Denmark, Region Skåne, and Nissan supported the data collection through their available channels to contact survey participants.

Data were collected through online surveys conducted in Sweden and Denmark from end of November 2016 until beginning of February 2017 (with a brake in data collection about ten days before and after Christmas). In Denmark and Sweden different sampling procedures were applied. In Denmark, emails with survey invitations were sent out to 2185 potential BEV owners and we received 595 answers (27%), of which 45 were deleted as they were not completed. Another eight cases were deleted as people did not have a car in the household anymore or data were inconsistent. Some participants owned a hybrid car and were not considered in this study, which only focusses on BEV users, so the final sample of BEV users in Denmark included 508 individuals.

Conventional car users in Denmark were contacted through the online panel of a market research institute (EPINION). The panel (“Danmarkspanelet”) consists of 244,568 members (with a monthly inflow of 7,510 new panellists) covering all regions of Denmark. People were included in the survey when the following criteria applied: holding a driving licence,

having a diesel/gasoline car, and not having an alternatively fuelled car in the household. The Danish sample of CV users included 829 individuals.

In Sweden, we were not able to contact BEV owners via email and thus distributed an anonymous link for survey participation. The invitation addressed both CV users and BEV users and was distributed via channels like the intranet of the regions Skåne and Västra Götaland, various newsletters, and electric vehicle related facebook groups. The Swedish sample consists of 165 CV users and 965 BEV users that comply with the definition outlined in the beginning of this section. The total sample including participants from Denmark and Sweden consists of 673 BEV users and 1794 CV users. A sample description is included in Table 3. The level of education of the sample is higher than in the general population. As the main part of conventional car users in Sweden are employees of Region Skåne and Västra Götaland, employees in working age are overrepresented here. Based on the method of data collection, we cannot claim representativeness of the sample.

3.2 Measures

The questionnaire included variables to measure attitudes and norms relate to BEVs, experiences with BEVs, mobility behaviour, and demographics. It took about 15 to 20 minutes to complete the online survey.

3.2.1 Attitudinal variables

The attitudinal factors included in this study were based on the TPB (see Table 1). Perceived behavioural control (PBC) was measured with statements referring to perceived functional barriers of BEV use, particularly the necessity to charge the car and limitations in

driving range. In addition to PBC, perceived mobility necessities (PMN, Haustein & Hunecke, 2007) were measured to account for aspects of the personal living situation that may hamper BEV adoption, namely a high need of spontaneity and mobility due to a busy lifestyle. Attitude was operationalized with statements refereeing to status and the symbolic value of BEVs as well as affective aspects related to driving pleasure and excitement and technical fascination. Items measuring subjective norm were supplemented by items measuring descriptive norm to increase variability (Ajzen, 2002). Finally, personal norm was operationalized by items focusing on the perceived obligation to take environmental consequences into account when choosing a car. All constructs were measured with at least two items and responses were provided on a 5-point-agreement-scale (1 = “totally disagree”, 5 = “totally agree”).

A principal component analysis with varimax rotation was carried out to reduce the number of psychological variables to their underlying dimensions. While the scree plot supported a 6-factor solution, the Eigenvalue criterion resulted in a 5-factor solution. Both solutions showed very similar results with the difference that symbolic and affective motives loaded on the same factor in the 5-factor solution, while they loaded on separate factors in the 6-factor solution. Because we considered this differentiation important, we selected the 6-factor solution, which explained 71% of the variance. Table 1 presents the loadings of the single items on the six factors. As a consequence of the choice of the 6-factor solution, we got three items with loadings of above .3 on two factors. However, the loadings on the main factor are all above .6 and on the second factors below or just .4, so that they allow for a clear allocation to one of the factors, and we do not consider them as relevant double loadings.

With Cronbach's alpha above .7 (mostly above .8), all factors have acceptable internal consistencies. Based on the allocation of items to the factors, which followed the theoretical expectations, six mean scales were calculated.

Table 1: Results of a principal component analysis on psychological items derived from an extended TPB

	1	2	3	4	5	6
	Perceived functional barriers (PBC)	**Subjective norm (SN)**	**Attitude: symbolic**	**Attitude: affective**	**Busy lifestyle (PMN)**	**Personal norm (PN)**
The need for charging makes electric cars very unpractical for use in everyday life.	**.775**	-.084	-.132	-.299	.048	-.127
Ensuring that an electric car is always charged makes it inconvenient to use.	**.787**	-.088	-.125	-.257	.056	-.101
Using an electric car requires a careful planning of activities.	**.782**	-.083	-.038	.118	.074	.039
When driving an electric car, I'm always (would always be) worried about running out of charge.[a]	**.767**	-.124	-.125	-.238	.058	-.073
Using an electric car for longer distances is difficult due to a lack of charging stations along the motorway.	**.745**	-.140	.030	-.066	.043	-.025
People who are important to me are considering to buy an electric car.	-.140	**.832**	.129	.130	.030	.149
People who are important to me own an electric car.	-.079	**.820**	-.014	.006	.012	-.019
People who are important to me think that my next car should be an electric car.	-.175	**.780**	.095	.209	-.006	.213
People who are important to me think that electric cars should play an important role in our transport system.	-.123	**.715**	.227	.202	.029	.279
I (would) feel embarrassed when driving an electric car.[a]	.171	-.010	**-.631**	-.203	.000	-.055
I (would) feel proud of having an electric car.[a]	-.213	.196	**.656**	.405	.010	.206
Driving an electric car expresses (my) environmental awareness.[a]	.087	.093	**.785**	-.024	.019	.305
Driving an electric car expresses (my) openness for new technologies.[a]	-.067	.138	**.707**	.325	.072	.065

It is fun to drive an electric car.	-.283	.185	.277	**.744**	.030	.176
The fast acceleration of an electric car is an exciting experience.	-.161	.133	.164	**.833**	.066	.054
I'm fascinated by the technology of electric cars.	-.164	.190	.386	**.647**	.042	.030
The organisation of my everyday life requires a high level of mobility.	.048	.012	.041	.034	**.902**	.001
I have to be mobile all the time to meet my obligations.	.035	.018	.014	.044	**.894**	.008
The possibility to change my plans spontaneously is very important to me.	.118	.018	.019	.020	**.750**	-.007
If I buy a car, I feel morally obliged to choose a car that minimises carbon emissions and air pollution.	-.089	.221	.215	.097	.004	**.871**
I feel obliged to take environmental consequences of vehicle use into account when choosing a car.	-.103	.233	.235	.110	-.006	**.856**
Cronbach's alpha	**.862**	**.853**	**.767**	**.812**	**.816**	**.871**

[a]Slightly different version were used for BEV users and non-users.

In addition to the operationalisation based on TPB constructs and its extensions, BEVs were evaluated based on single attributes, namely (1) purchase price, (2) public incentives, (3) maintenance costs, (4) driving range, (5) chargers where people live or work, (6) chargers along the motorway, and (7) environmental performance. Answers were provided on a 5-point Likert scale (1= very dissatisfying to 5 = very satisfying). Purchase price and public incentives were merged to a new variable "price" based on the means of both items (Cronbach's alpha = .59 for BEV users and .73 for non-users). CV users were further asked how important the seven attributes were for their BEV purchase considerations (unless they never considered to buy a BEV); and BEV users were asked how important these aspects were when they bought a BEV (retrospectively). Answers were provided on a 5-point Likert scale (1= "not important at all"; 5 = "very important").

Intention to buy or use a BEV was operationalised by three items referring to the likelihood that the next car will be a BEV (measured on a scale from 0 = "not likely at all" to 10 "extremely likely") and two items measured on a 5-point agreement scale (1 = "totally disagree", 5 = "totally agree"): one referring to the intention to use a BEV when available and one related to BEV purchase. Due to the different answer scales, the items were z-standardised before they were merged to a mean scale. The wording and statistics of the intention items are provided in Table 2.

Table 2: Statistics of the items measuring intention

Intention items	CV users		BEV users	
	M	*SD*	*M*	*SD*
My next car will be an electric car. (5-point scale)	2.62	1.00	4.50	0.81
If I had an electric car and a normal car available, I would mainly use the electric car. (5-point scale)	3.64	1.02	4.76	0.52
How likely is it that your next car will be a battery electric car? (11-point scale)	3.49	2.83	8.92	1.81
Cronbach's alpha (after z-standardisation)	.77		.78	

3.2.2 BEV experience

CV users were asked if they ever charged a BEV and if they ever drove in a BEV (as driver, passenger or both) and how they rated their first experience in case of having driven in a BEV (from 0 = "extremely negative" to 10 "extremely positive"). BEV users were asked if they changed their mobility patterns since they had a BEV (yes/no). In case they reported a change, they were asked in what way they changed their activity patterns based on the following answer alternatives (multiple responses allowed): "plan longer car trips more carefully"; "do not travel long distances by car anymore"; "use other modes of transport more

often"; "use other modes of transport less often", "other changes"). The answers to "other changes" were coded into additional categories.

3.2.3 Mobility behaviour and car use

People were asked how many days per week they used the following transport modes: car as driver, passenger, bike, public transport. In addition, they were asked for each car type available in their household (gasoline/diesel car; battery electric car; other alternatively fuelled car), how often a car of that type was used for each of seven different trip purposes (1 = "never"; 6 = "5 time a week or more", see Table 5 for trip purposes), how many km were driven with that car type per week and if it had been used to travel to a foreign country within the past 5 years.

3.2.4 Demographics

As sociodemographic variables age, gender, education, employment status, income, and household composition were requested. Participants were further asked how many cars of which type they had in their household and if they had access to a private parking place where a charger for a BEV could be setup. People with a BEV in their household were asked for the car make of the BEV.

3.3 Analysis

In this paper, we first compare BEV users and CV users to confirm and extent the results of other studies that we are dealing with two distinct target groups. Socio-demographic and attitudinal profiles of BEV and CV users are compared and differences are tested for significance based on Chi^2-tests and ANOVAs, depending on the scale of measurement (see

Section 4.1). In addition, the frequency of use of different transport modes is compared for CV and BEV users in single versus multiple-car households and tested for significance by t-tests. We then compare for what purposes BEVs and CVs are used in the household and if there are significant differences in the use of CVs and BEVs in households that have both car types available (tested by t-test for paired samples). To protect from Type I Error, we applied Bonferroni correction. Accounting for 41 comparisons between BEV and CV users, the *p*-value has to be below .001 for the test results to be considered statistically significant according to the original level of significance *($p < .05$)*.

In the second part of the analysis (Section 4.2), we examine the factors of BEV usage and purchase intention separately for both groups as a basis for the deduction of targeted interventions to increase BEV adoption. Potential factors of intention are included in two separate linear regression analysis – one for BEV users and one for CV users. In both models, psychological factors are included first, while we in a second step control for the effect of sociodemographic, infrastructural factors, and BEV experience that may be related to the psychological variables. In an additional linear regression analysis, BEV usage (as a share of total car usage) is modelled based on the same factors for people with a BEV and other car type(s) in their household.

4 Results

4.1 Comparison of CV and BEV users

4.1.1 Socio-demographic profiles

Despite some sample specific differences between Denmark and Sweden, Table 3 clearly

reveals that BEV users differ from CV users in terms of socio-demography: People with a BEV in their household who answered the survey were almost completely male, they had higher household incomes and higher education levels, were more often self-employed, lived less often alone and more often had smaller children in their household. In addition, BEV households more often had more than one car, particularly in Sweden, where the average number of cars is higher than in Denmark.

Table 3: Socio-demographic profiles of CV and BEV users by country

		CV users			BEV users			CV vs. BEV *p* (Chi^2- tests)
		DK	**SE**	**all**	**DK**	**SE**	**all**	
Gender	Male	51%	33%	42%	91%	95%	92%	.000
Age	18-35	37%	16%	26%	12%	13%	12%	.000
	36-59	41%	70%	57%	69%	71%	70%	
	60+	22%	14%	18%	18%	16%	18%	
Income	Less than 20.000 kr.	20%	14%	16%	3%	7%	4%	.000
	20.000-29.999 kr.	21%	48%	36%	12%	30%	17%	
	30.000-39.999 kr.	22%	19%	21%	15%	28%	18%	
	40.000-49.999 kr.	16%	8%	11%	22%	13%	20%	
	50.000 or more	22%	11%	16%	49%	22%	42%	
Employment status[a]	Employee	63%	97%		67%	64%		.000 (self-employed)
	Self-employed	6%	2%	4%	23%	27%	24%	
	Student	9%	1%		1%	0%		
	Pensioner, early retirement	13%	1%		8%	8%		
	Other	9%	0%		2%	1%		
Education[a]	University education	53%	59%	56%	78%	60%	73%	.000
Household composition	One person HH	17%	13%	15%	7%	6%	7%	.000
	Children below 10 year in household	28%	26%	27%	32%	38%	34%	.000
Cars in the household	One car	67%	46%	56%	40%	27%	37%	.000
	Two cars	31%	44%	38%	49%	53%	50%	
	More than two cars	2%	10%	6%	11%	20%	14%	

Note. [a] Different categories were used for employment status and education in DK and Sweden, thus not all results are comparable between Denmark (DK) and Sweden (SE).

The results are in line with the differences found in other studies (e.g., Peters & Dütschke, 2014; Hjorthol, 2013; Nayum et al., 2016) and confirm that we are dealing with separate target groups.

4.1.2 Mobility patterns

We compared how often people in BEV households and in CV households used different modes of transport. As mode choice differs with gender, and BEV users in the sample were almost completely male, we only included men in this comparison. In addition, the results are presented separately for single and multiple car households as BEV households are more often multiple car households. As Table 4 reveals, BEV users in single car households used the car on more days per week as drivers than CV users.

Table 4: Use of different transport mode by car household type (only men included)

	Single car household			Multiple car household		
Average days per week with transport mode	CV	BEV	*p* (*t*-test)	CV	BEV	*p* (*t*-test)
Car, driver	5.04	5.60	.000	5.70	5.81	.022
Car, passenger	2.84	2.92	.417	3.37	3.18	.030
PT	2.98	2.71	.034	2.49	2.18	.002
Bicycle	3.27	3.43	.290	2.46	2.79	.003

When comparing how frequently BEVs and CVs were used in the household for different purpose, we find that BEVs were used for all purposes more frequently than CVs, no matter if the BEV was the only car or if there was an additional car in the household (see Table 5). When we only included people in this analysis who had both a BEV and a CV in their household, so that the results of both car types relate to the same household, these

differences become even more pronounced and were statistically significant for commuting to work, bringing or picking up children, leisure activities, and private errands.

Table 5: Trip purpose by car and household type

	Single car household		Multiple car household		BEV household with BEV and CV		
	BEV	CV	BEV	CV	BEV	CV	*p* (paired *t*-test)
Travel to work	4.58	4.18	5.20	5.02	5.13	4.04	.000
Bringing/picking up children or others	3.78	2.96	4.09	3.36	4.03	3.00	.000
Leisure activities	3.92	3.39	4.23	3.58	4.21	3.04	.000
Shopping	4.17	3.91	4.48	3.93	4.45	3.18	.075
Private errands (e.g., appointment at doctor, bank)	3.24	2.86	3.61	3.00	3.59	2.73	.000
Vacation/weekend trips (incl. summerhouse)	2.53	2.28	2.50	2.27	2.48	2.14	.448
Business trips	1.94	1.49	2.24	1.84	2.18	1.74	.008

Note. 1= “never”; 6 = “5 times a week or more”.

For both car types it was asked if the car type was used to travel to other countries in the past 5 years. For CVs the percentage was 64.7%, while it was 49.6% for BEVs.

4.1.3 BEV experience

CV users were asked if they had ever travelled in a BEV. While 63.1% had never travelled in a BEV before, 35.5 % had travelled in a BEV either as passenger (14.5%), driver (12.5%) or both (9.6%). The experience was mostly described as positive (M = 7.6 on a scale from 0-10, SD = 2.0). With 11.8% a lower percentage reported that they had tried recharging a BEV.

BEV users were asked if they changed their activity patterns since they had a BEV in their household. Almost half (47.1%) of BEV users reported that they had changed their

activity patterns: 37.6% planned longer trips more carefully; 13.9% used other modes less often, 5.9% did not travel longer distances anymore; and 4.2% used other transport modes more often. Fifteen percent reported other changes and described the respective change(s) in an open answer. The open responses were categorized and about half of them (48.0%) referred to driving more often, either for specific purposes (e.g., for shopping or short distances in general), because it was more fun to drive a BEV or because they felt less concerned about the environment when driving a BEV. All other categories were mentioned by less than 10 percent of respondents and are thus not reported here.

4.1.4 BEV attitudes and norms

As the means in Table 6 show, people with only CVs in their household differ clearly from BEV users with regard to higher perceived functional barriers, and lower norms and attitudes towards BEVs. As the means and effect sizes show, differences are most pronounced for affective attitudes and functional barriers. Other than expected, BEV and CV users do not differ with regard to perceived mobility necessities and also the difference with regard to personal norm is comparably small. When comparing Swedish and Danish participants, we find that Swedes have a bit more positive attitudes and perceive less barriers towards BEV usage. Even though some of these differences are statistically significant, the effect sizes are so small ($Eta^2 < .1$) that we do not consider them as relevant.

Table 6: Differences in psychological factors of BEV and CV users by country

Car user group	Country		Perceived functional barriers (PBC)	Attitude: symbolic	Attitude: affective	Subjective norm (SN)	Personal norm (PN)	Busy lifestyle (PMN)
CV users	DK	*M*	3.55	3.74	3.33	2.42	3.21	3.49
		SD	0.72	0.70	0.70	0.80	1.06	0.92
	SE	*M*	3.51	4.03	3.42	2.38	3.37	3.67
		SD	0.76	0.70	0.77	0.88	1.12	0.91
	DK vs. SE	*p*	.271	.000	.010	.267	.003	.000
		Eta^2	.001	.041	.004	.001	.005	.010
BEV users	DK	*M*	2.59	4.42	4.52	3.06	3.97	3.67
		SD	0.82	0.49	0.53	0.77	1.05	0.82
	SE	*M*	2.05	4.58	4.63	3.10	4.02	3.67
		SD	0.70	0.43	0.47	0.83	1.13	0.80
	DK vs. SE	*p*	.000	.000	.015	.600	.647	.936
		Eta^2	.078	.020	.009	.000	.000	.000
CV vs. BEV users (across country)		*p*	.000	.000	.000	.000	.000	.030
		Eta^2	.280	.127	.364	.115	.075	.002

BEV users were further asked how important specific BEV characteristics were for their BEV purchase (retrospectively), while CV users were asked how important these aspects were for their considerations to buy a BEV (people who never considered to buy a BEV were not asked this question). People in both groups were additionally asked how they currently evaluated these aspects. Figure 1 summarises the results based on the means. Both groups were most satisfied with BEV's environmental performance and maintenance costs, though on a different level. BEV users were most dissatisfied with public incentives, while CV users were most dissatisfied with the purchase price. Both aspects were, however, rated quite low in both groups, while BEV users were much more satisfied with the charging situation than CV users. When comparing the scores for importance and satisfactions, BEV users showed the greatest discrepancy with regard to public incentives, followed by purchase

price and driving range, while CV users showed the greatest discrepancy for purchase price, followed by the number of chargers. As a pilot test revealed that a lot of CV users felt not competent to evaluate the different BEV characteristics, we included the answer category "don't know" for these questions. This category was chosen most frequently for the evaluation of "chargers along the motorway" (42.1%), "maintenance costs" (35.5%), and "chargers where I live or work" (27.1%).

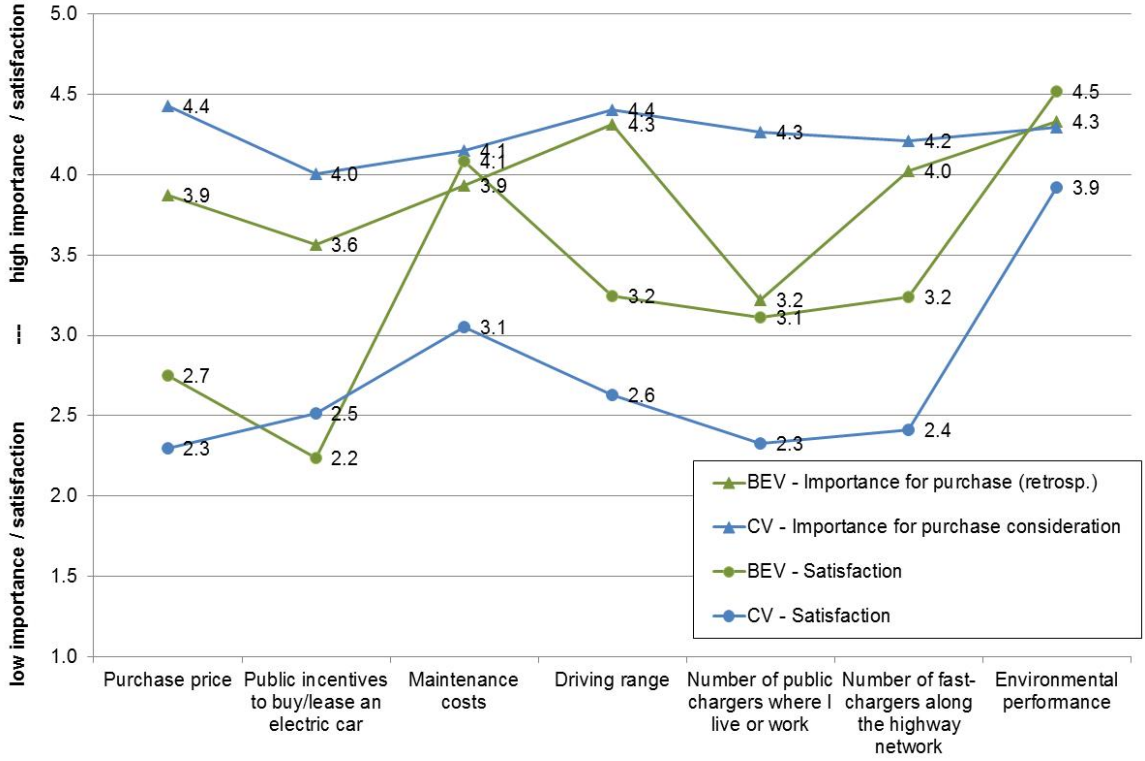

Figure 1: Average importance and satisfaction ratings (5-point Likert scales) on BEV characteristics by BEV and CV users (excluding people who answered "don't know")

4.2 Factors of BEV adoption

4.2.1 Intention to use/purchase a BEV among BEV and CV users

To examine, which factors are related to BEV users' and CV users' intention to buy/use a BEV, separate linear regression analysis were calculated. In a first step (Model 1, see Table 7), we included SN, PN, PBC, PMN, the symbolic and affective BEV attitudes as well as those BEV evaluations that were not better covered by the perceived functional barriers variable (PBC), namely price, maintenance costs, and environmental performance. We found that for CV users symbolic attitudes were the most important factor, indicating that people who associate a positive image and high status with BEV ownership are more likely to buy a BEV. Affective attitudes in terms of driving pleasure and excitement as well as perceived barriers (PBC) were also significant, followed by subjective and personal norm. In case of BEV users, functional barriers were by far the most important factor of intention, indicating that people who had experienced problems with charging and driving range are less likely to buy a BEV again. Both affective and symbolic attitudes were also relevant, while norms seem to be much more relevant for first buying a BEV than for buying a BEV again. A lifestyle characterized by perceived mobility needs and a need for spontaneity (PMN) surprisingly did not influence BEV adoption in both groups. With regard to functional aspects, we found that the price was significantly related to CV users' intention, while this was not the case for BEV users.

When socio-demographic factors as well as factors related to experience with BEVs were included in the analyses (Model 2, see Table 7), the effect of the single TPB predictors did not change significantly and also the total explained variance did not grow considerably. Two factors that now additionally had a significant effect in case of CV users were gender and education, showing a higher BEV intention for males and people with university

education. In both groups, Swedes showed a higher intention to buy a BEV as compared to Danes, which cannot be explained with different socio-demographic characteristics and different attitudes and norms, as these were controlled for in the analysis.

Having tried to drive in a BEV and having charged a BEV was not significantly related to CV users' intention. However, BEV users who had changed their mobility patterns by planning longer trips more carefully since they had access to a BEV, showed a higher intention to buy a BEV again ($p < .05$), while BEV users who since they changed to a BEV did not travel longer distance anymore, were less likely to buy a BEV again ($p = .05$). Whether BEV users had used other modes more or less often did not have a significant effect on intention.

4.2.2 Factors of BEV usage

The same factors[1] that we used to model BEV usage/purchase intention were used in a linear regression analysis to model actual BEV usage. BEV usage was calculated as the percentage of kilometres travelled by BEV of the total car mileage in the household. We only included people with more than one car in their household in the analysis as BEV usage for single BEV households is per definition hundred percent. We found three factors significantly related to BEV usage: having a diesel/gasoline car in the household decreased BEV usage ($\beta = -.37$, $p < .001$) as did perceived functional barriers for BEV use ($\beta = -.25$, $p <$

[1] Except for satisfaction with price / public incentives, which we do not consider relevant for usage, when a BEV is already available in the household.

.001). Finally, BEV adaption in form of planning longer trips more carefully had a positive effect on BEV usage ($\beta = .10$, $p < .05$).

Table 7: Linear regression analysis modelling CV and BEV users' intention to buy/use a BEV

	CV users' intention				**BEV users' intention**			
	Model 1		Model 2		Model 1		Model 2	
	Beta	*p*	Beta	*p*	Beta	*p*	Beta	*p*
Perceived functional barriers (PBC)	-.236	.000	-.219	.000	-.341	.000	-.326	.000
Attitude: symbolic	.310	.000	.316	.000	.213	.000	.181	.000
Attitude: affective	.240	.000	.196	.000	.224	.000	.222	.000
Subjective norm (SN)	.183	.000	.180	.000	.091	.006	.084	.014
Personal norm (PN)	.113	.000	.122	.000	.041	.263	.041	.274
Busy lifestyle (PMN)	-.017	.423	-.039	.084	-.059	.061	-.044	.191
Satisfaction with price / public incentives	.065	.007	.075	.002	.033	.281	.009	.782
Satisfaction with maintenance costs	.033	.209	.024	.369	-.003	.928	.012	.721
Satisfaction with environmental performance	.011	.642	.018	.469	.080	.025	.073	.050
Age			.138	.346			.229	.343
Age^2			-.208	.156			-.245	.306
Gender			-.090	.000			.057	.079
Income			.001	.964			-.036	.327
University education			.046	.039			-.045	.177
Self-employed			.020	.338			.035	.288
Total number of household members			-.019	.496			-.085	.055
Number of children under 10 years in HH			-.020	.456			.047	.272
Country: Sweden (reference: Denmark)			.086	.000			.084	.030
Number cars in household			.012	.599			-.014	.744
Gasoline/diesel car							-.047	.276
BEV is a Tesla							.038	.252
Access to a private parking place			.050	.026			-.043	.201
Ever travelled in BEV?			.033	.167				
Ever recharged a battery electric car?			-.001	.966				
Change: Plan longer car trips more carefully.							.072	.040
Change: I do not travel long distances by car anymore							-.071	.050
Change: I use other modes of transport more often.							.035	.315
Change: I use other modes of transport less often.							-.036	.284
R^2 (adjusted R^2)	.558 (.555)		.582 (.572)		.406 (.398)		.442 (.416)	

Note. Missings were excluded pairwise.

5 Discussion

As a basis for the derivation of targeted interventions to increase BEV adoption, the overall aim of this study was to examine the factors related to BEV adoption among BEV users and CV users based on an extended version of the TPB. As expected, all TPB constructs (attitude, subjective norm, perceived behavioural control) have been found related to BEV usage and purchase intention. The explained variance and the beta-weights in the regression analyses remained almost stable when background variables were additionally included, which stresses the relevance of the TPB constructs for explaining BEV adoption. When comparing the results of the regression analyses for BEV and CV users, we found relevant differences which indicate that results in relation to BEV users cannot be generalised to other vehicle user populations and vice versa. For BEV users, perceived functional barriers with regard to charging the car was the most important factor of BEV purchase intention and was also relevant for current BEV usage. Thus, to retain existing BEV users, an increase of the existing charging infrastructure is of highest relevance.

For CV users' intention, attitudes were of higher importance, particularly symbolic attitudes related to BEVs. Affective attitudes, such as driving pleasure, showed a comparable impact on both groups. As expected and in line with Peters and Dütschke (2014), subjective norm showed a larger impact on CV users than on BEV users. To attract new BEV customers, it thus seems most relevant to improve the image that BEV have in society to address both subjective norm and symbolic attitude. People who would feel proud when having a BEV and think that BEVs express environmental awareness and openness for new technologies are more likely to consider buying a BEV. These are aspects that could be used

for promotional campaigns by trying to connect BEV use both to environmental values and technological progress and promote BEV as a status symbol for green technologies. Here, it may also be relevant to differentiate between subgroups attracted more by environmental motives versus technology and innovation as indicated by a recent market segmentation study (Morton, Anable, & Nelson, 2017). Apart from symbolic marketing, it seems highly relevant to inform about recent improvements in driving range of BEVs as many CV users feel unable to assess how satisfying the driving range of BEV is and when they do so, their ratings are much worse than the ratings of BEV users. The latter may indicate other demands but also information deficits about new technological developments and improvements.

As expected, the (limited) satisfaction with the purchase price and public incentives played a larger role for CV users than for the more affluent BEV users. Financial support for BEV purchase is thus expected to increase BEV adoption in the general population and extend the profile of typical BEV users.

Compared to the three original TPB-factors, the added factors, namely personal norm (PN) and perceived mobility necessities (PMN) showed a comparably low effect on intention: PN only affected CV users' but not BEV users' intention. The latter can probably be explained with a low variance in PN among BEV users who differed significantly from CV users by a higher PN. In Norway, PN was not able to differentiate between electric car owners and owners of other car segments (see Nayum et al., 2016). This indicates that in countries with more restricted public incentives for BEV purchase and use, like Denmark, Sweden and most other European countries (as compared to Norway), the Norm-Activation Model and its central variable PN is a useful addition to TPB factors, while this intrinsic

moral obligation to behave environmentally friendly plays a minor role when sufficient extrinsic motivations are provided, for example in form of high financial incentives for BEV purchase as in Norway.

Other than expected, PMN were not significantly related to BEV usage/purchase intention when other factors were controlled for. This result is in conflict with results of previous studies, which showed that the perceived compatibility of a BEV with personal (mobility) needs is a relevant barrier of BEV purchase (Jensen et al., 2014; Peters & Dütschke, 2014). The missing impact may either be related to the lower specificity of the concept of PMN, as the related items are formulated more generally and with no direct connection to BEVs, or the lifestyle component may partly be covered by other factors included in this study, such as symbolic attitudes and perceived functional barriers, which were included in the other studies in less detail. In case of BEV users, it may also be covered by the question if/in what way they adapted their activity pattern since having a BEV. We found that individuals, who state that they plan longer trips more carefully, are actually more likely to purchase a BEV again, while people who do not drive long distance anymore, are less likely to do that. This indicates that finding a way to deal with travelling longer distances by a BEV or being willing to do so is an important behavioural adaption to make. Individuals should be supported in this process by relevant information but also by improvements and extension of the charging infrastructure, so that the need for behavioural adaption decreases.

In case of CV users, BEV experience (having driven or charged a BEV) was not significantly related to intention. However, one can assume that this experience led to a

change in attitudes (as shown in previous studies, e.g. Jensen et al., 2013; Schmalfuß et al., 2017), so that the potential effect of experience is covered by the effect of attitudes.

While characteristics of BEV owners found in this study resample results of previous studies, showing that BEV owners are more likely to be male, of higher education and income, and live more likely with children and more than one car in the household, most of these factors show no impact on BEV purchase intention when they are included in a regression analysis together with psychological factors. Exceptions are male gender and higher education, which are related to a higher purchase intention of CV users – but not BEV users. The latter can be explained with the fact that BEV users are very homogeneous with regard to these characteristics.

A result that cannot satisfactorily be explained based on the data is that living in Sweden is positively related to BEV purchase intention. Because of the different sampling strategies in both countries, it is likely that more people considering to buy a BEV participated in the Swedish survey. However, as demographics, attitudes, norms and barriers were included in the regression analyses, differences in these factors cannot explain the differences in intention.

A potential explanation for the country-specific differences may be found in the political environment and level of uncertainty with regard to future changes in the car market. Since 2010, BEVs in Denmark have been exempt from registration tax, which at that time was between 105% and 180% of the value of the car. However, the current government has decided to gradually normalize the registration tax for BEVs from 2016 to 2022. Furthermore, the current government has reduced the registration tax for conventional cars

three times in the last two years, and thereby increased the cost difference between BEVs and CVs. By contrast, the Swedish scheme of public incentives for BEV purchase (a subsidy of 40,000 Swedish kroner (about 4,000 Euros) for vehicles emitting less than 50g/km; see Region Skåne, 2017) has been stable for several years and thus uncertainty about the public support for BEVs probably plays a minor role in Sweden. To confirm this assumption, future studies should include measures on the perceived uncertainty of financial and political support for BEVs as factors of purchase intention.

A result that is in line with findings from earlier studies is that BEV users drive more than CV users (Fujii, 2010; Langbroek et al., 2017). This can on the one hand be explained by the comparably high purchase price, which could mean that buyers are mostly people with a high interest in cars (and driving) but also that the higher price is more acceptable for people with a higher driving need as the initial costs are compensated over time by lower BEV driving and maintenance cost. However, research also suggests that people actually first start driving more when having a BEV. Fujii (2010) showed that driving distance one year after car purchase was 1.64 times higher for people who perceived their car to be an eco-car than for those who did not and the increase in driving was particular higher when assuming that eco-cars could solve environmental problems. Recent studies show that BEVs are used for a higher share of total trips and for more, especially shorter trips (Labeye et al., 2016; Langbroek et al., 2017). The open answers provided in our survey with regard to changes in activity patterns provide some insight into what motives may be responsible for the higher amount of shorter trips. In several answers, the stated increase of (shorter) car trips was justified by the lower environmental consequences of BEVs as compared to CV, which is in

line with the findings and interpretations by Fujii (2010), Labeye et al. (2016), and Langbroek et al. (2017). Another explanation may be the increased driving pleasure, which was also reported by some individuals in our study as a reason for increased car use. However, our study did not ask systematically for an increase or decrease in car use and the related reasons, thus the results should be interpreted with care.

Generally, self-reported data can be biased by factors such as social desirability (Lajunen & Summala, 2003) and the retrospectively reported behavioural adaptions may be subject to memory bias and/or hindsight bias (Roese & Vohs, 2012). Longitudinal studies including the same people before and after BEV purchase are suggested to examine behavioural adaption more reliably and with the possibility for drawing causal conclusions.

The convenience sample in case of Sweden can be regarded as a limitation of this study and a survey using the same sampling procedure in both countries should be used to clarify the country specific differences. In general, we expect that our results are transferable to other European countries with reasonably comparable framework conditions, such as Germany or the United Kingdom, though this needs to be confirmed by futures studies.

6 Conclusions

This study shows that CV user and BEV users are distinct target groups that differ in demographics, mobility patterns and attitudes on BEV. When aiming at increasing BEV adoption, different strategies are indicated for both groups: For CV users, main efforts need to be put in measures to improve the image of BEVs as “green” status symbols and in filling knowledge gaps concerning driving range and related improvements. Additionally, gaining

practical experience with BEVs trough trials seems to be a promising strategy to increase affective attitudes in relation to BEVs. However, as the effects of experience on functional attitudes and purchase intention are found to be neutral or even negative (e.g. Jensen et al., 2013; Schmalfuß et al., 2017), efforts have to be taken to increase confidence in the actual improvements in infrastructure and driving range, to avoid that perceived functional restrictions outweigh the positive driving experience.

To avoid that the positive environmental consequences of BEV purchase are eroded by higher car usage, as indicated in some recent studies, communication that overestimates the environmental advantages of BEVs should be avoided as well as public incentives that support BEV usage at the expense of cycling and public transport use.

For BEV users, the improvement of the charging infrastructure is of highest importance, particularly to encourage people to use the BEV also for long-distance trips. Increasing the number of chargers along the motorway network and providing simple and compatible payment solutions across Europe seems important to avoid that current BEV users turn back to a CV when experiencing that their mobility needs cannot be covered satisfactorily by a BEV, in particular when it is the only car in the household.

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